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Keys to the Adult Ticks of *Haemaphysalis* Koch, 1844, in
Thailand with Notes on Changes in Taxonomy
(Acari: Ixodoidea: Ixodidae)

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ABSTRACT Specimens of the genus *Haemaphysalis* collected in Thailand were examined, and a key to the adults of 24 species belonging to six subgenera is presented. We propose that *H. wellingtoni* Nuttall & Warburton, 1908, be placed in the subgenus *Katseriana*, *H. obesa* Laroousse, 1925, be moved from *Segalia* to *Katseriana*, and that *H. cornigera* Neumann, 1897, be removed from the species list of Thailand.

KEY WORDS Arachnida, ticks, *Haemaphysalis*, taxonomic keys

Haemaphysalis is the second largest tick genus in the family Ixodidae and consists of about 155 species. All known *Haemaphysalis* species are parasitic on birds and mammals and have a three-host life cycle. For many *Haemaphysalis* species, the hosts of immatures are significantly different from hosts of adults. Within this genus, many species are vectors of disease agents such as Russian spring-summer encephalitis and Kyasanur Forest disease (Hoogstraal 1970, 1981). In epidemiological research, recognition of the correct tick species is a significant factor. The epidemiology and occurrence of tick-borne diseases in Thailand and most of the rest of Southeast Asia are poorly understood. One reason is that adequate regional keys to the species of ticks present are not available. Keys to the haemaphysalid ticks of Indonesia (Anastos 1950), South India (Trapido et al. 1964), and Japan (Yamaguti et al. 1971) have been published, but few of these species are found in Thailand.

In this paper we present a key to the subgenera and species of *Haemaphysalis* of Thailand. From this study, we propose two subgeneric changes. *H. wellingtoni* Nuttall & Warburton, which was of uncertain status, be placed in *Katseriana*, and *H. obesa* Laroousse be moved from *Segalia* to *Katseriana*. We also propose that Thai specimens identified as *H. cornigera* are actually *H. shimoga*, therefore removing *H. cornigera* from the species list of Thailand. The key includes 24 species distributed among the following subgenera: *Aborphyssalis* Hoogstraal & El Kaimmah (3 species), *Garnhamphyssalis* Hoogstraal & Wassef (1 species), *Haemaphysalis* Koch (1 species), *Katseriana* Santos Dias (10 species), *Ornithophysalis* Hoogstraal & Wassef (4 species), *Rhipistoma* Koch (4 species), and one species of uncertain subgenus.

Materials and Methods

This paper is based upon morphological characteristics of tick specimens collected in Thailand between 1961 and 1983 by personnel of the Department of Medical Entomology, United States Army Medical Component, Armed Forces Research Institute of Medical Sciences (AFRIMS). In preparing drawings and keys for male or female ticks of species for which Thailand specimens were not available, we used specimens from nearby countries or from published descriptions; these are indicated in the figure captions. In addition, some ticks of birds were obtained from H. Elliott McClure, Migratory Animal Population Studies (MAPS), Thailand Institute of Scientific and Technological Research, Curators at the British Museum (Natural History) (BM), Museum of Comparative Zoology, Harvard University (MCZ), and the Smithsonian Institution (SI) kindly loaned many specimens of various *Haemaphysalis* species from the following countries: India, Burma, Laos, Cambodia, Vietnam, Hong Kong, Thailand, Malaysia, and Singapore.

The arrangement of subgeneric taxa follows Hoogstraal & Kim (1985). Discussions of the subgenera are arranged in the order in which they appear in the key. Ixodid morphology, including characters used in the keys of the genus *Haemaphysalis*, are illustrated and explained in Fig. 1 and its legend. A host-parasite list is included (Appendix 1).

Key to Adults of the Subgenera of *Haemaphysalis*

1. Posterodorsal margin of palpal segment 3 with distinct or indistinct spur in one or both

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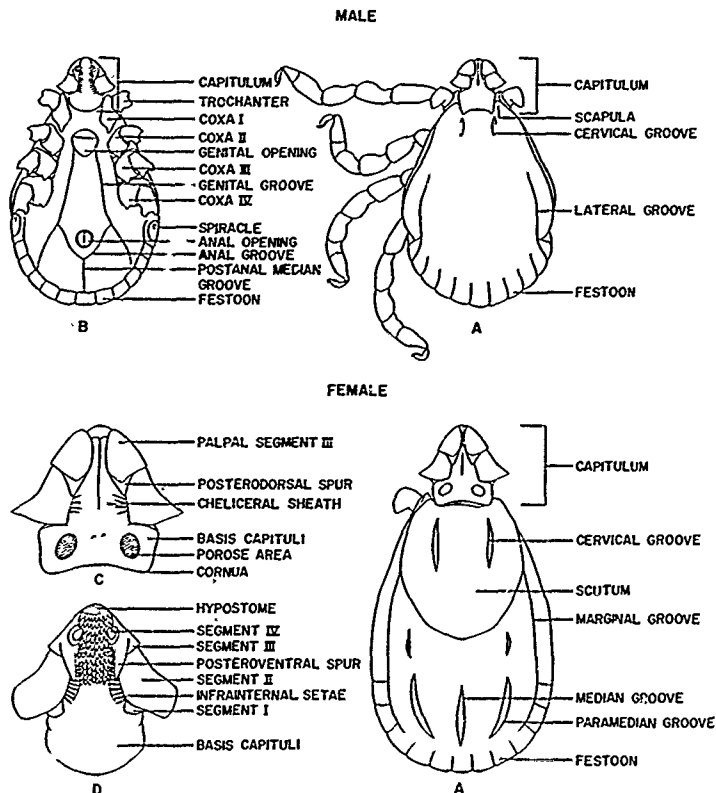
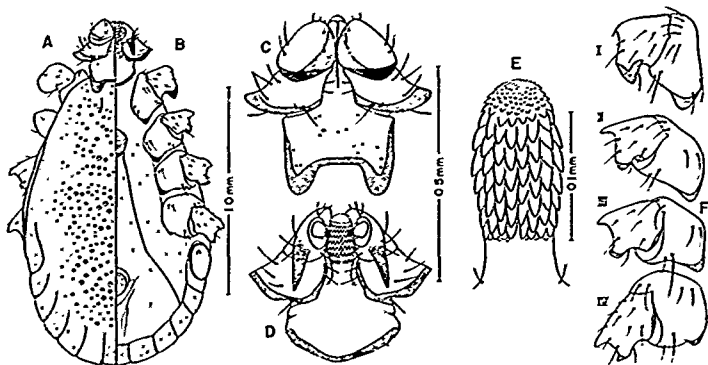


Fig. 1. Isodid morphology and characters used in the keys of the genus *Haemaphysalis*. *H. (K.) usslingi* Nuttall & Warburton (A) Dorsal view (B) Ventral view (C) Capitulum, dorsal view. (D) Capitulum, ventral view (E) Hypostome, ventral view (F) Coxae and trochanters I-IV (G) Genital area. (H) Femur IV (I) Spiracle. (J) Plate. Legend applies to all figures.

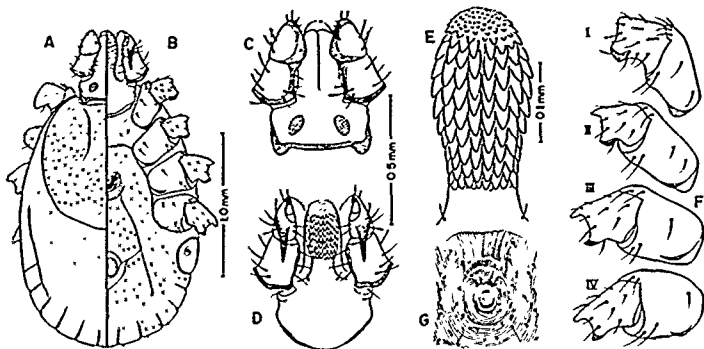
- sees, or with platelike projection, posteroventral spur prominent, triangular, overlapping at least $\frac{1}{2}$ of anterior part of segment 2; extraordinarily long spurs on coxa IV of one sex present or absent 2
- Posterodorsal margin of palpal segment 3 without spur or platelike projection, posteroventral spur of variable size; coxa IV without extraordinarily long spur 3
2. Posterodorsal margin of palpal segment 3 with platelike projection, cornua and coxal spur replaced by platelike projections (Fig. 2) Subgenus uncertain

- Posterodorsal margin of palpal segment 3 with distinct or indistinct, median or internal spur, cornua and coxal spur broadly or elongately triangular, coxa IV sometimes with extraordinarily long spurs in one sex (Fig. 3-12) *Katseriana*
3. Palpi broadly salient basally 4
- Palpi compact without posterior flange or campanulate with a moderate posterior flange 5
4. Body elongate; posterodorsal and posteroventral margins of palpal segment 2 with spurs or spurs and grooves, ventral spur of palpal

MALE (Thailand)



FEMALE (Thailand)

Fig. 2. *Haemaphysalis traguli* Oudemans, 1928.

- segment 3 strongly developed (Fig. 13-16) *Rhipistoma*
 Body oval, posterodorsal and posteroventral margins of palpal segment 2 without spurs or grooves; ventral spur of palpal segment 3 mildly developed (except *H. ornithophylla*) (Fig. 17-20) *Ornithophysalis*
 5. Palpi compact without posterior flange; ventral spur of segment 3 short and broadly triangular, extending to or slightly beyond basal margin of segment (Fig. 21-23) *Aborphysalis*
 Palpi campanulate with a moderate posterior flange in one or both sexes; ventral spur of segment 3 long, broadly or elongately triangular, overlapping at least apical 1/3 of segment 2 6
 6. Ventral spur of palpal segment 3 elongately triangular, overlapping at least anterior 1/2 of segment 2, coxal spurs long, elongately triangular (Fig. 24) *Garnhamphysalis*
 Ventral spur of segment 3 broadly triangular, overlapping anterior one-third of segment 2; coxal spurs short, broadly triangular (Fig. 25) *Haemaphysalis*

Subgenus *Uncertain*

Material Examined. THAILAND: 2 ♂ (AFRIMS), 13 ♂ (BM), 7 ♀ (BM). MALAYSIA: 17 ♂ (SI), 1 ♂ (BM), 7 ♀ (SI), 1 ♀ (BM). VIETNAM: 1 ♂ (SI).

Discussion. *Haemaphysalis traguli* Oudemans, 1928, is the only species of the genus in Thailand not assigned to a subgenus (*incertae sedis*). Both males and females were examined (Fig. 2).

Subgenus *Kaiseriana*Key to Species of the Subgenus
Kaiseriana

Males

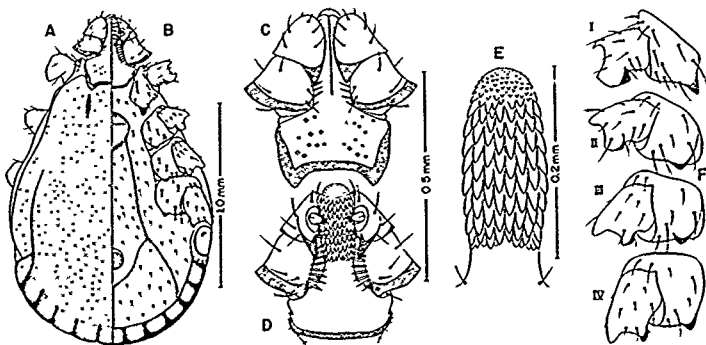
1. Posterodorsal margin of palpal segment 3 with distinct, flat, internal and retroverted spur, ventral spur posterointernally directed; coxa IV without extraordinarily long spur (Fig. 3) *wellingtoni* Nuttall & Warburton
- Posterodorsal margin of palpal segment 3 with distinct or indistinct, median or internal spur; ventral spur posteromedially directed; coxa IV sometimes with extraordinarily long spur. 2
2. Palpi widely salient basally, posterodorsal margin of palpal segment 3 with indistinct V-shaped spur near or at inner margin; coxa IV with 2 extraordinarily long spurs (*cornigera* group) 3
- Palpi compact or campanulate, without basolateral salience, posterodorsal margin of palpal segment 3 with distinct or indistinct spur at midbreath, coxa IV spur single, short, broadly triangular 4
3. Palpi broadly triangular, posterodorsal margin of segment 3 with indistinct V-shaped spur at inner margin; posterior margin of segment 2 crenulate with several surface folds; spurs of coxa IV posterointernally directed (Fig. 4) *anomala* Warburton
- Palpi truncate, with number of bizarre planes and angles, posterodorsal margin of segment 3 with small, indistinct V-shaped spur near inner margin; posteroventral margin of segment 2 with large lateral spur, posteriorly directed at external margin; spurs of coxa IV posteriorly or posterolaterally directed (Fig. 5) *shimoga* Trapido & Hoogstraal
4. Palpi compact, subquadrate, posterodorsal spur of segment 3 indistinct, short, widely triangular or crestlike, slightly overlapping apical part of segment 2; dental formula 4/4 or 5/5 (*nadchatrami* group) 5
- Palpi campanulate, posterodorsal spur of segment 3 distinct, sharply triangular, overlapping ½ or more of anterior part of segment 2; dental formula 4/4 8
5. Dental formula 4/4 6
- Dental formula 5/5 7
6. Posterodorsal spur of palpal segment 3 crestlike; lateral grooves indistinct, very short, extending anteriorly, not reaching level of coxa IV, posteriorly enclosing first festoon (Fig. 6) *papua* Thorell
- Posterodorsal spur of palpal segment 3 widely triangular with pointed apex, lateral grooves short, indistinct or obsolete, posteriorly not enclosing first festoon (Fig. 7) *nadchatrami* Hoogstraal, Trapido & Kohls
7. Circumspiracular setae present, partly visible dorsally; femur IV with ventral inner row of 18-20 closely spaced setae, lateral grooves present, short, anteriorly to level of coxa IV, posteriorly not enclosing first festoon (Fig. 8) *obesa* Larrousse
- Circumspiracular setae absent; femur IV with ventral inner row of 7-11 setae, lateral grooves absent (Fig. 9) *semermis* Neumann¹
8. Posterodorsal spur of palpal segment 3 overlapping ½ of anterior part of segment 2, posteroventral margin of segment 2 with spurlike angle medially; lateral grooves absent (Fig. 10) *hystrix* Supino
- Posterodorsal spur of palpal segment 3 overlapping ½ or more of anterior part of segment 2; posteroventral margin of segment 2 without spurlike angle, lateral grooves present (*bispinosa* group) 9
9. Posteroventral spur of palpal segment 3 elongately triangular, pointed apex, overlapping anterior ½ of segment 2; spurs of coxae II-IV prominently triangular with pointed apices, lateral grooves indistinct, short, extending from anterior margin of first festoon to level of coxa III (Fig. 11) *lagrangei* Larrousse
- Posteroventral spur of palpal segment 3 broadly triangular, blunt apex, overlapping anterior ½ of segment 2; spurs of coxae II-IV short, broadly ridge-like, lateral grooves distinct, long, extending from anterior margin of first festoon to level of coxa II (Fig. 12) *bispinosa* Neumann

Females

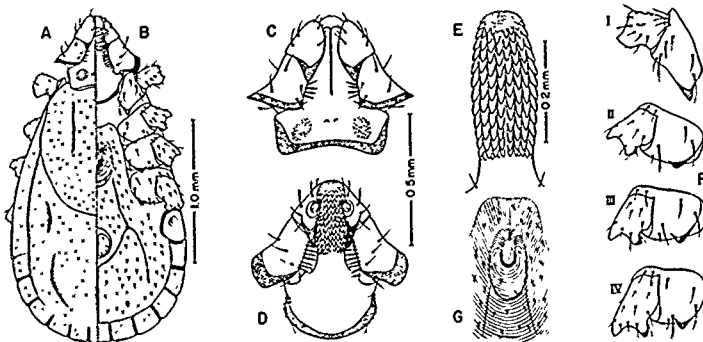
1. Posterodorsal margin of palpal segment 3 with distinct, flat, internal and retroverted spur, ventral spur posterointernally directed (Fig. 3) *wellingtoni* Nuttall & Warburton
- Posterodorsal margin of palpal segment 3 with median spur posteriorly directed, ventral spur posteromedially directed 2
2. Palpi widely salient basally (*cornigera* group) 3
- Palpi compact or broadly campanulate, with or without slightly basolateral salience 4

¹ Specimen not examined, only a female specimen has been found (deposited in the Field Museum of Natural History)

MALE (Thailand)



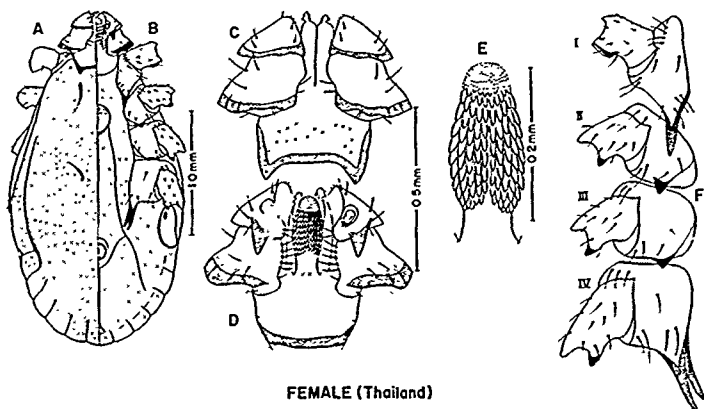
FEMALE (Thailand)

Fig. 3. *Haemaphysalis* (K.) *wellingtoni* Nuttall & Warburton, 1908.

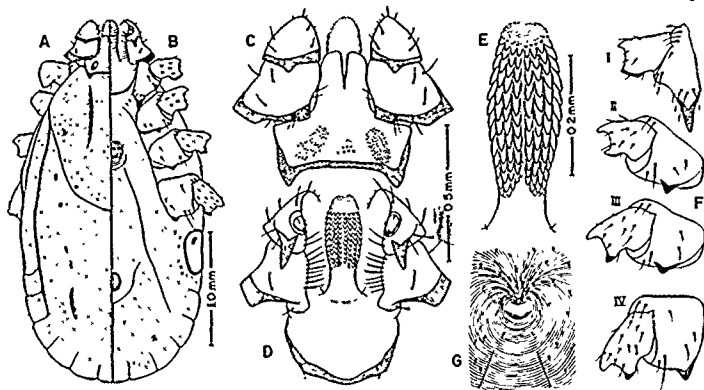
3. Posterior margin of palpal segment 2 crenulate with few surface folds, infrainternal setae 8 (Fig. 4) *anomala* Warburton
- Posterior margin of palpal segment 2 not crenulate, external margin with posterodorsal projection, infrainternal setae 5 (Fig. 5) *shimoga* Trapido & Hoogstraal
4. Palpi compact, slightly basolateral salience present or absent, posterodorsal spur of segment 3 short, widely triangular or crestlike, slightly overlapping apical part of segment 2; dental formula 4/1 or 5/5 (*nadchatrami* group) 5

- Palpi broadly campanulate with slight basolateral salience, posterodorsal spur of palpal segment 3 prominent, broadly triangular, overlapping anterior 1/4 or more of segment 2, posterodorsal margin of segment 2 with or without spurlike angle, dental formula 4/4 8
- 5 Dental formula 4/4 6
- Dental formula 5/5 7
- 6 Palpi with slightly basolateral salience, posterodorsal spur of palpal segment 3 short, crestlike (Fig. 6) *papuana* Thorell
- Palpi without slight basolateral salience, pos-

MALE (Thailand)



FEMALE (Thailand)

Fig. 1. *Haemaphysalis (K.) anomala* Warburton, 1913

- terodorsal spur of palpal segment 3 broadly triangular, pointed apex (Fig. 7).....
nadchatrami Hoogstraal, Trapido & Kohls
 7 Circumspiracular setae present, femur IV with ventral inner row of 18-20 closely spaced setae (Fig. 8).....*obesa* Larrousse
 Circumspiracular setae absent; femur IV with ventral inner row of 7-11 setae (Fig. 9).....*semermis* Neumann
 8. Posterodorsal spur of palpal segment 3 overlapping anterior 1/4 of segment 2; postero-

- ventral margin of segment 2 with spurlike angle (Fig. 10).....*hystricis* Supino
 Posterodorsal spur of palpal segment 3 overlapping anterior 1/4 of segment 2, postero-ventral margin of segment 2 without spurlike angle (*bispinosa* group).....
 9 Ventral spur of palpal segment 3 elongately triangular, pointed apex, reaching posterior 1/4 of segment 2; spurs of coxae II-IV short, broadly triangular (Fig. 11).....
lagrangei Larrousse

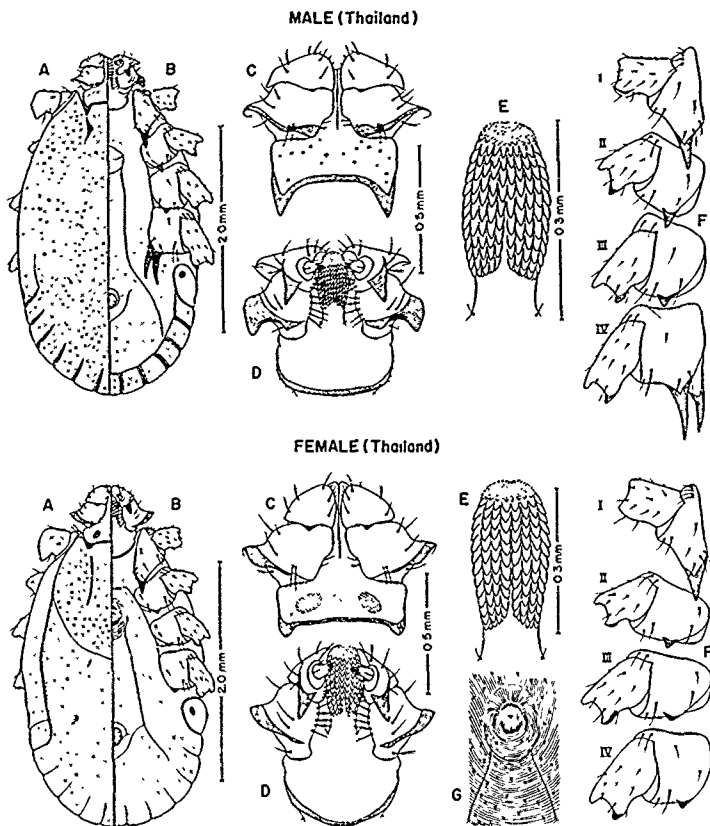


Fig. 5. *Haemaphysalis* (*K.*) *shimoga* Trapido & Hoogstraal, 1964.

Ventral spur of palpal segment 3 broadly triangular, blunt apex, overlapping anterior $\frac{1}{2}$ of segment 2, spurs of coxae II-IV short, broadly ridgelike (Fig. 12) *bispinosa* Neumann

Material Examined. *H. (K.) anomala* THAILAND 11 ♂♂ (AFRIMS), 13 ♀♀ (AFRIMS) *H. (K.) bispinosa*: THAILAND 1 ♂ (AFRIMS), 12 ♀♀ (AFRIMS) BURMA 21 ♀♀ (SI) MALAYSIA 86 ♂♂ (SI), 31 ♀♀ (SI) SINGAPORE 2 ♂♂ (BM), 2 ♀♀ (BM) *H. (K.) hystrix*: THAILAND 3 ♂♂ (AFRIMS), 2 ♂♂

(BM), 10 ♀♀ (AFRIMS) HONG KONG 1 ♂ (BM), 1 ♀ (BM) LAOS 2 ♂♂ (MCZ) *H. (K.) lagrangei* THAILAND, 40 ♂♂ (AFRIMS), 29 ♀♀ (AFRIMS) *H. (K.) nadchatrami*: THAILAND: 7 ♂♂ (AFRIMS), 13 ♀♀ (AFRIMS). *H. (K.) obesa*: THAILAND: 31 ♂♂ (AFRIMS), 39 ♀♀ (AFRIMS) *H. (K.) papuana* THAILAND: 35 ♂♂ (AFRIMS), 14 ♀♀ (AFRIMS) *H. (K.) semernus* MALAYSIA. 1 ♂ (BM), 2 ♀♀ (BM) *H. (K.) shimoga* THAILAND 23 ♂♂ (AFRIMS), 1 ♂ (SI), 37 ♀♀ (AFRIMS), 1 ♀ (SI) BURMA 66 ♂♂ (SI), 17 ♀♀ (SI) INDIA 1 ♂ (SI), 2 ♀♀ (SI) VIETNAM 2 ♂♂ (SI), 2 ♀♀ (SI). CAMBODIA.

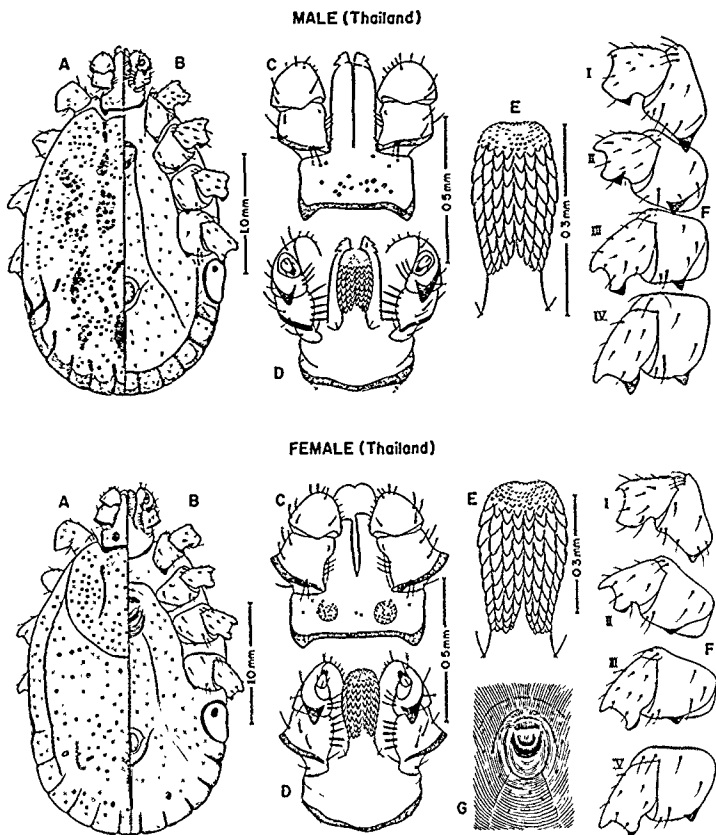


Fig. 6. *Haemaphysalis* (K.) *papuana* Thorell, 1883.

9 ♂♂ (SI), 27 ♀♀ (SI) *H. (K.) wellingtoni* THAILAND 36 ♂♂ (AFRIMS), 5 ♀♀ (AFRIMS).

Discussion. The major criterion of the subgenus *Kaiseriana* is the presence of at least one of the following characters (Hoogstraal & Kim 1985) (1) the presence of a more or less developed dorsobasal spur or elevation (hair-hooking device) on palpal segment 3 in one or both adult sexes, (2) the presence of a hair grasping gap which is formed by the broad posterior expansion and apical recurvation of the movable segment 3 and the anterior

narrowing of segment 2, or (3) the palpi are campanulate and the posterodorsal margin of palpal segment 3 is uniquely recurved internally rather than medially spurred. Hoogstraal et al (1965) placed *H. wellingtoni* in subgenus *Kaiseriana* on the basis of having the first character listed above. Tansul et al. (1983) moved it from the subgenus to *incertae sedis* (by suggestion of Hoogstraal in a personal communication), and indeed when Hoogstraal & Kim (1985) published a paper on *Haemaphysalis*, they did not mention *wellingtoni* or *traguli*. In preparing this paper we have examined

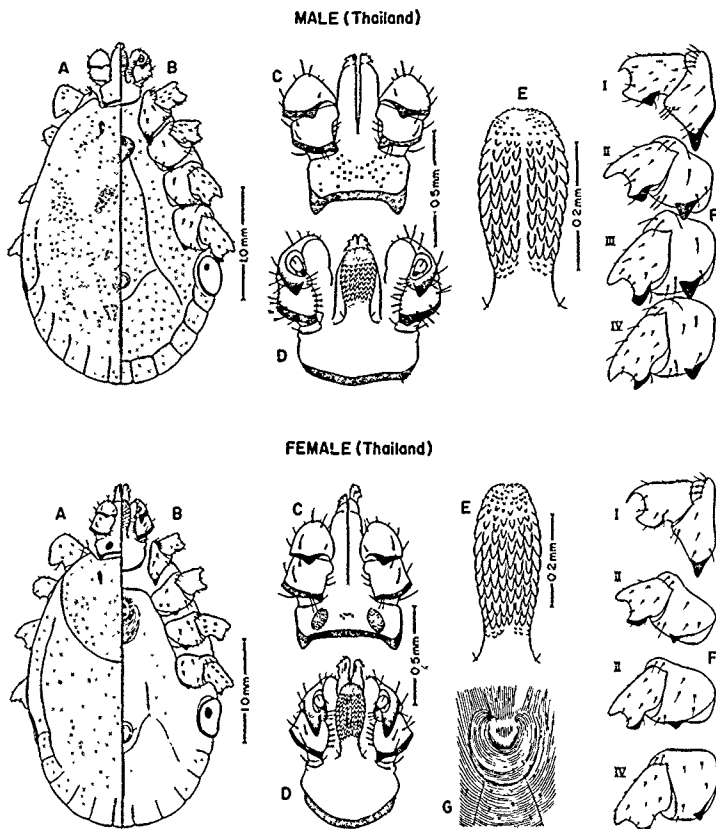
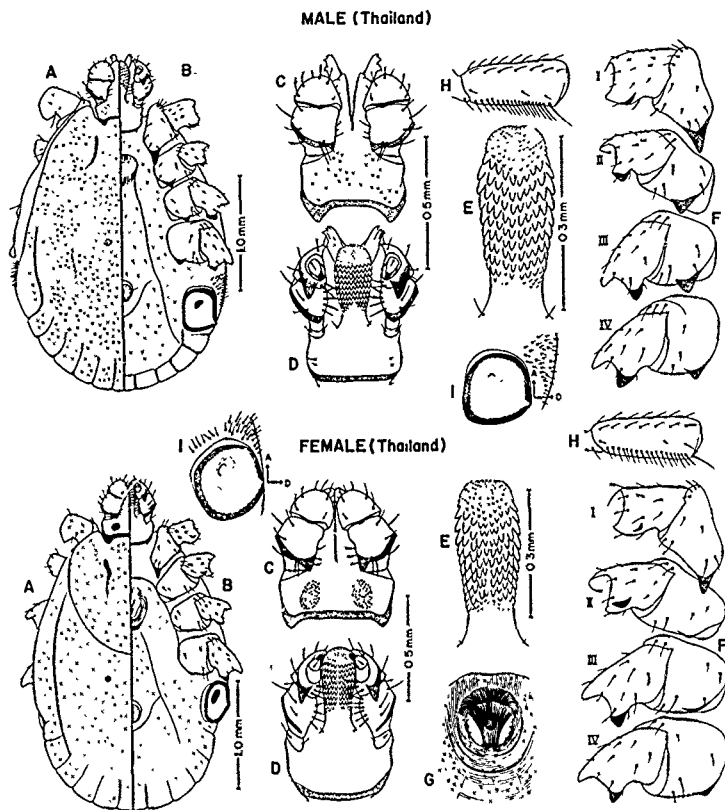


Fig. 7. *Haemaphysalis* (K.) *nadechatranii* Hoogstraal, Trapido & Kohls, 1965

the ticks carefully and have decided to reassign *wellingtoni* to *Kaiseriana* on the basis of having the first and the third characters listed above; *traguli* remains in uncertain status (*incertae sedis*).

Haemaphysalis obesa was erected by Larrousse (1925, as cited in Hoogstraal et al. 1966). Hoogstraal et al. (1966) placed it in *Kaiseriana*, but then (Hoogstraal et al. 1971a) first moved it to subgenus *Haemaphysalis* and then (Hoogstraal & Kim 1985) to *Segalia*. However by the character of its palpi, we judge that *obesa* should be in *Kaiseriana*.

Trapido & Hoogstraal (1964) described *H. shimoga* as a subspecies of *H. cornigera*. Tanskul et al. (1983) separated *shimoga* as a full species, a decision later confirmed by Hoogstraal & Kim (1985). In examining material for this paper, we found that all Thailand specimens previously identified as *H. cornigera* agree in all essential details with type specimens of *H. shimoga* (RML 39300, RML 39301). Furthermore, specimens previously identified as *H. cornigera* vary significantly from Nuttall & Warburton's (1915) redescription of the

Fig. 8. *Haemaphysalis (K.) obesa* Larrouse, 1925.

species. Consequently, we regard *H. cornigera* to be absent from Thailand.

Subgenus *Rhipistoma*

Key to Species of the Subgenus *Rhipistoma*

Males

- 1 Posterodorsal margin of palpal segment 2 with 2 distinct spurs separated by groove, dental formula 6/6-8/8, lateral grooves distinct, moderately long, extending anteriorly to

- level of coxa III, posteriorly enclosing first 2 festoons (Fig. 13). *asiatica* (Supino)
- 2 Posterodorsal margin of palpal segment 2 with one distinct spur, dental formula 4/4; lateral grooves distinct or indistinct, length variable. *2*
- 2 Posterodorsal spur of palpal segment 2 at external margin, lateral grooves indistinct, extending anteriorly to level of coxa III, posteriorly to anterior margin of first festoon, coxae I-IV each with prominent spur, broadly triangular, spur of coxa I the longest (Fig. 14) *heymrichi* Schulze

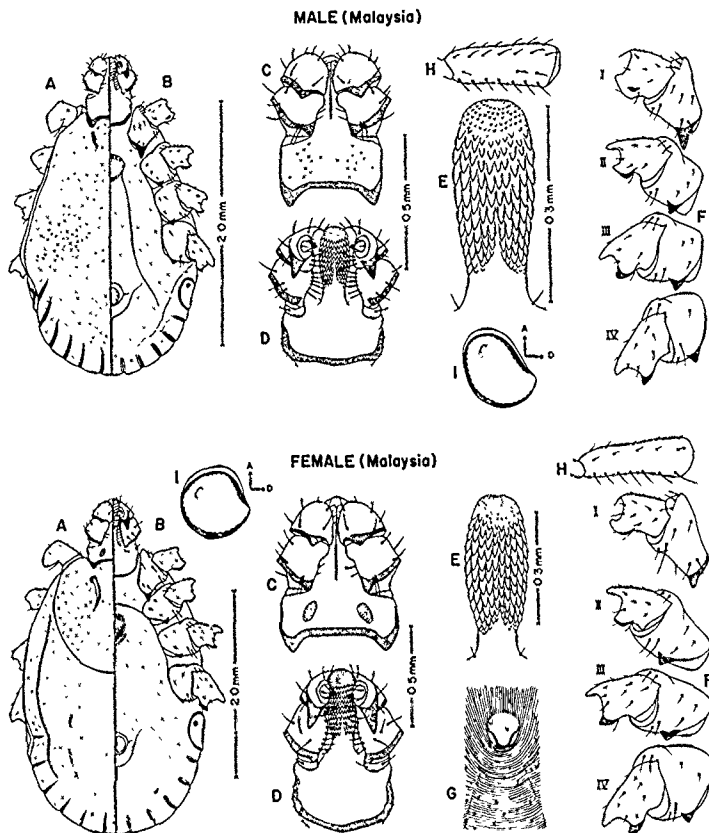


Fig. 9. *Haemaphysalis* (K.) *semermus* Neumann, 1901 (specimen from Thailand not seen, drawings were prepared from Malaysian specimen).

Posterodorsal spur of palpal segment 2 at marginal midbreadth, lateral grooves distinct, length variable, coxae I-IV each with small triangular spur, subequal..... 3

3. Posterodorsal spur of palpal segment 2 elongate triangular, pointed apex; lateral grooves extending anteriorly to level of coxa III, posteriorly enclosing first festoon (Fig. 15)..... *canestrinii* (Supino)

Posterodorsal spur of palpal segment 2 broadly triangular, blunt apex; lateral grooves

extending anteriorly to level of coxa III, posteriorly to anterior margin of first festoon (Fig. 16)..... *koningsbergi* Warburton & Nuttall

Females

- 1 Posterodorsal margin of palpal segment 2 with 2 distinct spurs separated by groove, the inner spur shorter, dental formula 6/6-8/8 (Fig. 13)..... *asiatica* (Supino)

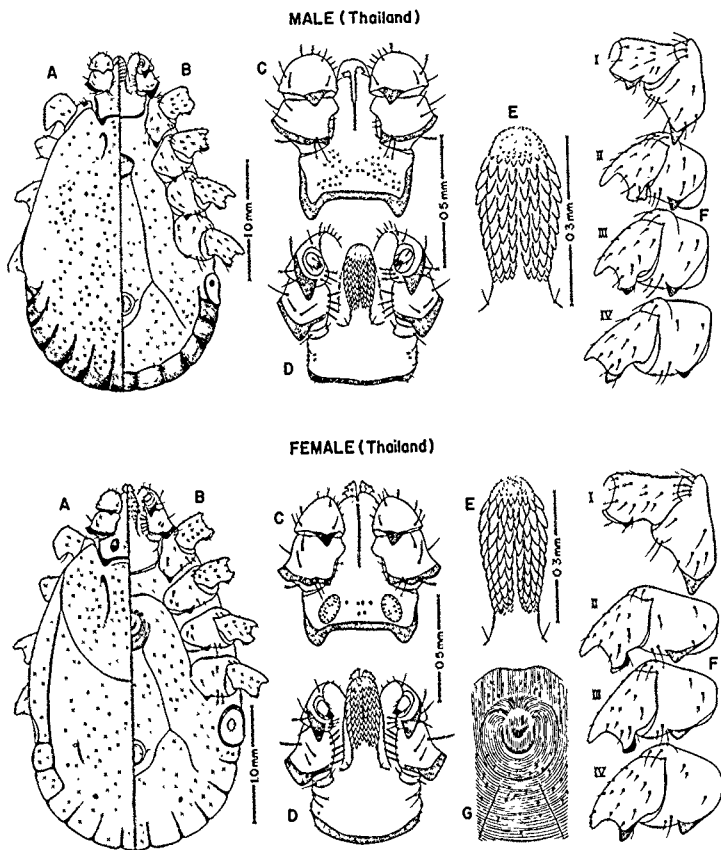


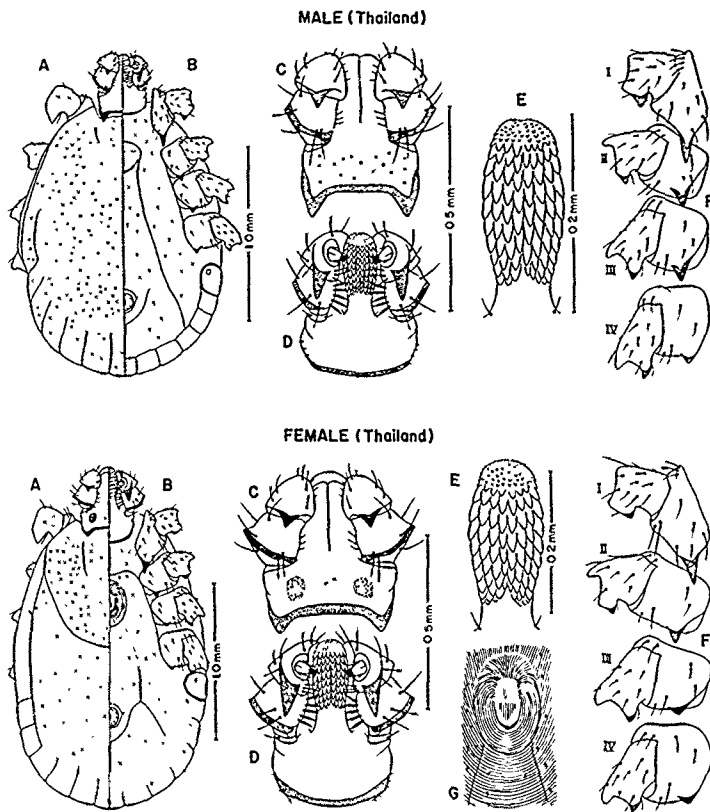
Fig. 10. *Haemaphysalis (K.) hystrix* Supino, 1897

Posterodorsal margin of palpal segment 2 with one distinct spur, the second spur if present, rudimentary, dental formula 4/4 or 5/5

2. Cornua long, broadly bladelike, $\frac{1}{2}$ as long as basis capituli, posterodorsal spur of palpal segment 2 at external margin, triangular, posterolaterally directed, dental formula 5/5 (Fig. 14) *heinrichi* Schulze
- Cornua short, broadly triangular, $\frac{1}{4}$ as long

as basis capituli, posterodorsal spur of palpal segment 2 at marginal midbreadth, posteriorly directed, dental formula 4/4

3. Cornua with pointed apex, posterodorsal margin of palpal segment 2 with one large, elongately triangular, pointed apex spur and one rudimentary spur, separated by indistinct groove, infracapitulum setae 7 (Fig. 15) *canestrinii* (Supino)
- Cornua with broadly rounded apex, postero-

Fig. 11. *Haemaphysalis* (K.) *lagrangeti* Larrousse, 1925

dorsal margin of palpal segment 2 with one broadly triangular, blunt apex spur, infrainternal setae 4 (Fig. 16).....
..... *koningsbergeri* Warburton & Nuttall¹

Material Examined. *H. (R.) asiatica*: THAILAND: 2 ♂♂ (AFRIMS), 8 ♀♀ (AFRIMS) *H. (R.) canestrinii*: THAILAND: 3 ♂♂ (AFRIMS), 8 ♂♂ (SI), 11 ♀♀ (SI). BURMA: 3 ♂♂ (MCZ), 1 ♀ (MCZ). *H. (R.) heinrichi*: THAILAND: 36 ♂♂ (AFRIMS), 13

♀♀ (AFRIMS) *H. (R.) koningsbergeri* THAILAND: 6 ♂♂ (AFRIMS), 2 ♂♂ (SI) MALAYSIA: 23 ♂♂ (SI), 1 ♂ (BM), 8 ♀♀ (SI), 1 ♀ (BM).

Subgenus *Ornithophysalis*

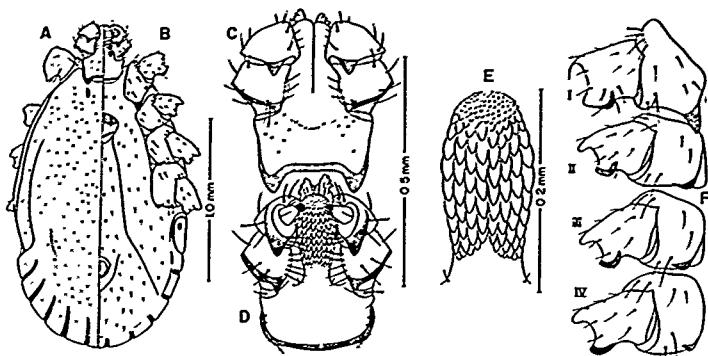
Key to Species of the Subgenus *Ornithophysalis*

Males

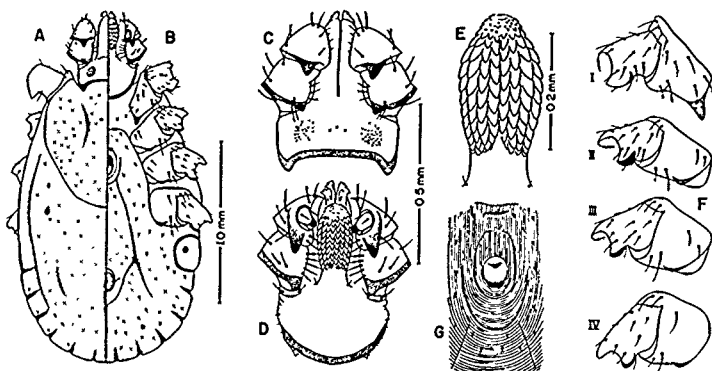
1. Ventral spur of palpal segment 3 elongately triangular, overlapping anterior 1/2 of segment 2, spurs of coxa I and trochanter I

¹Specimen not found

MALE (Thailand)



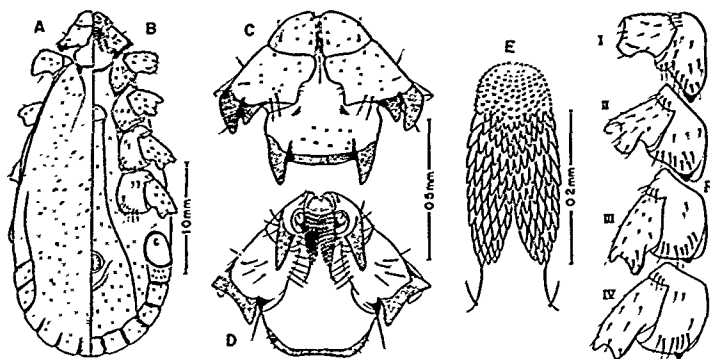
FEMALE (Thailand)

Fig. 12. *Haemaphysalis* (K.) *bispinosa* Neumann, 1897

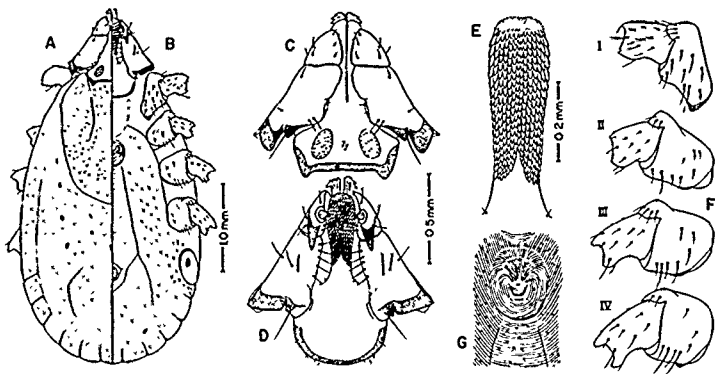
- large, sharply pointed apex (Fig. 17).....
ornithophila Hoogstraal & Kohls
 Ventral spur of palpal segment 3 short, broadly triangular, not reaching or slightly extending beyond intersegmental suture; spur of coxa I short, broadly triangular or ridge-like, spur of trochanter I obscure 2
 2 Ventral spur of palpal segment 3 not reaching intersegmental suture; infrainternal setae bristlelike, 4, coxae I-IV each with short ridge-like projection (Fig. 18)
megalaimae Rajagopalan²

- Ventral spur of palpal segment 3 extending slightly beyond intersegmental suture, infrainternal setae widely lanceolate, 4 or 8, coxae I-IV each with short, broadly triangular spur..... 3
 3 Palpal segment 2 appearing somewhat broken at midlength in lateral profile, ventral spur of segment 3 broadly triangular, infrainternal setae 8, lateral grooves long, extending anteriorly to level of coxa II, posteriorly enclosing first 2 festoons (Fig. 19)
doenitzii Warburton & Nuttall

MALE (Thailand)



FEMALE (Thailand)

Fig. 13. *Haemaphysalis* (R.) *astatica* (Supino, 1897)

Palpal segment 2 unbroken in lateral profile, ventral spur of palpal segment 3 narrowly triangular; infrainternal setae 4; lateral grooves long, extending anteriorly to level of coxa II, posteriorly enclosing first festoon (Fig. 20) *bandicota* Hoogstraal & Kohls

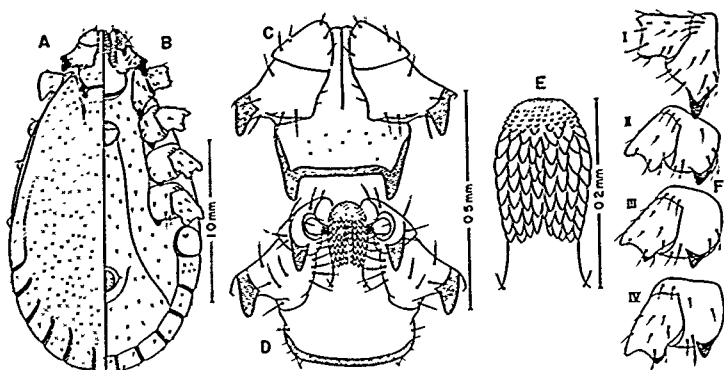
Females

- 1 Ventral spur of palpal segment 3 elongately triangular, overlapping anterior $\frac{1}{2}$ of segment 2, cornua long, broadly triangular

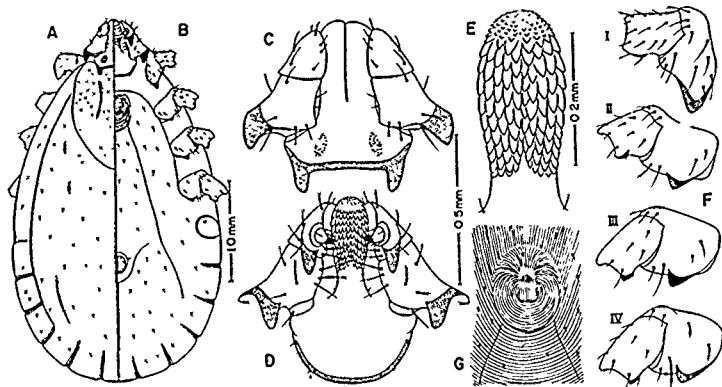
about $\frac{1}{2}$ as long as basis capituli, spurs of coxa I and trochanter I large, sharply pointed apex (Fig. 17)

- *ornithophila* Hoogstraal & Kohls
- Ventral spur of palpal segment 3 short, broadly triangular, not reaching or slightly extending beyond intersegment suture, cornua short and small, about $\frac{1}{4}$ as long as basis capituli; spur of coxa I short, broadly triangular or ridgelike, spur of trochanter obscure
 - 2 Ventral spur of palpal segment 3 not reaching

MALE (Thailand)

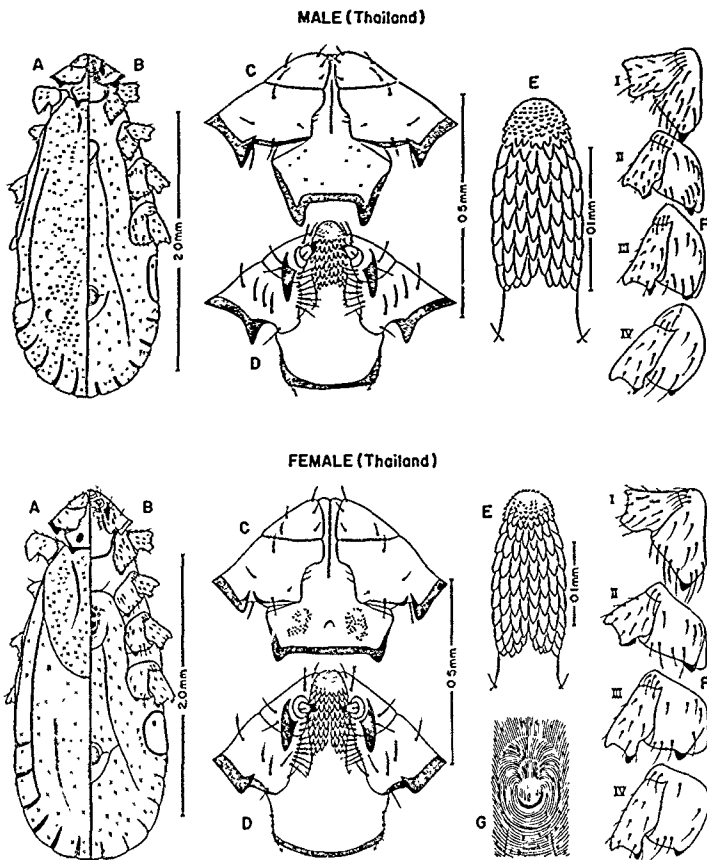


FEMALE (Thailand)

Fig. 11. *Haemaphysalis (R.) heinrichi* Schulze, 1939.

intersegmental suture; infrainternal setae bristlelike 4; coxae I-IV each with short, ridge-like projection (Fig. 18).....*megalaema* Rajagopalan²
 Ventral spur of p 1pal segment 3 extending slightly beyond intersegmental suture, infrainternal setae widely lanceolate, 6 or 8; coxae I-IV each with short broadly triangular spur..... 3

- 3 Palpal segment 2 appearing somewhat broken at midlength in lateral profile, ventral spur of palpal segment 3 broadly triangular; infrainternal setae 8 (Fig. 19)
*doenitzii* Warburton & Nuttall
 Palpal segment 2 unbroken in lateral profile, ventral spur of palpal segment 3 narrowly triangular, infrainternal setae 6 (Fig. 20)
*bandicota* Hoogstraal & Kohls

Fig. 15. *Haemaphysalis* (R.) *canestrinii* (Supino, 1897)

Material Examined. *H. (O.) bandicota*: THAILAND: 58 ♂♂ (AFRIMS), 13 ♀♀ (AFRIMS). *H. (O.) doenitzii*: THAILAND: 5 ♂♂ (AFRIMS), 8 ♀♀ (AFRIMS). *H. (O.) megalotmae*: THAILAND: 7 ♂♂ (SI), *H. (O.) ornithophila*: THAILAND 1 ♂ (MCZ), 1 ♀ (MCZ)

Subgenus *Aborphysalis*

Key to Species of the Subgenus *Aborphysalis*

Males

- 1 Posterior margin of palpal segment 2 forming short, wide, spurlike angle dorsally and

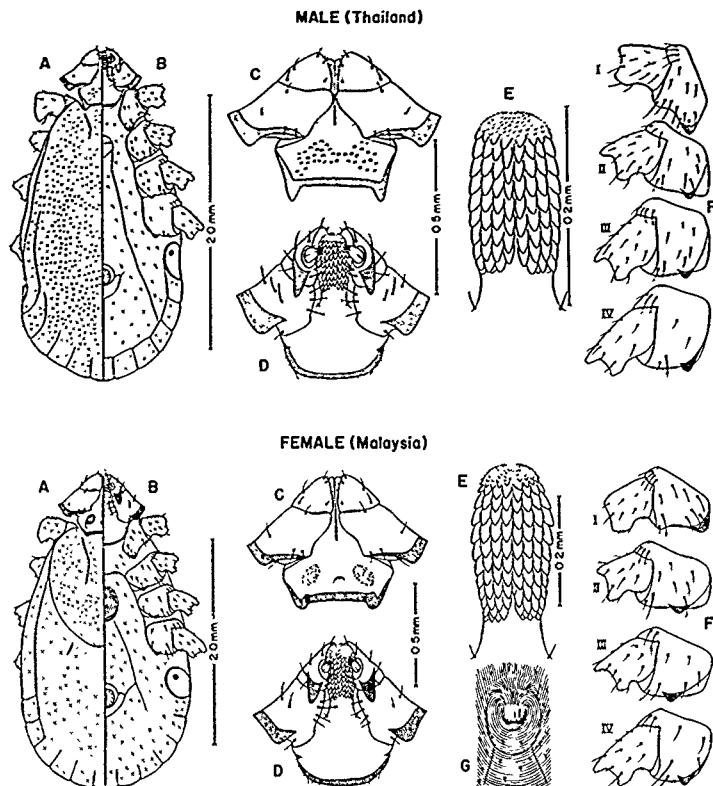


Fig. 16. *Haemaphysalis (R.) koningsbergeri* Warburton & Nuttall, 1909 (female specimen from Thailand not found; drawings were prepared from Malaysian specimen).

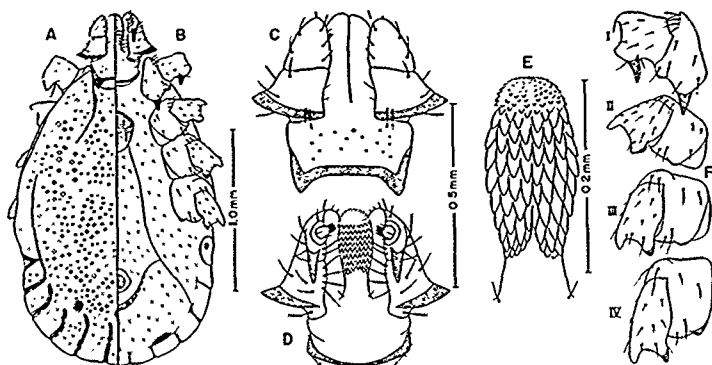
ventrally, segment 3 with crenulate posterodorsal margin, coxae I-IV each with ridge replacing spur, lateral grooves distinct, short, extending anteriorly to level of coxa IV, posteriorly enclosing first festoon, dental formula 4/4 (Fig. 21).....

.....*capricornis* Hoogstraal
Posterior margin of palpal segment 2 without spurlike angle on both sides, posterodorsal margin of segment 3 straight or slightly undulant, coxae I-IV each with prominent

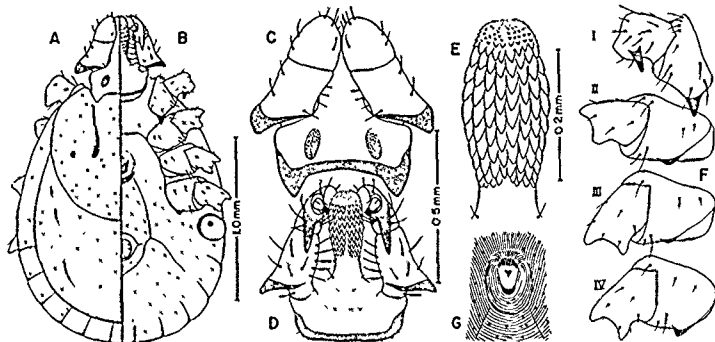
triangular spur, lateral grooves distinct or indistinct, dental formula 4/1 or 5/5 ... 2

- 2 Ventral spur of palpal segment 3 with blunt apex, not extending beyond basal margin of segment; lateral grooves indistinct or obsolete, dental formula 4/4 (Fig. 22)....
.....*atherurus* Hoogstraal, Trapido & Kohls
Ventral spur of palpal segment 3 with pointed apex, extending slightly beyond basal margin of segment, lateral grooves distinct, extending anteriorly to level of coxa III, pos-

MALE (holotype, Thailand)



FEMALE (allotype, Thailand)

Fig. 17. *Haemaphysalis* (*O.*) *ornithophila* Hoogstraal & Kohls, 1909.

teriorly enclosing first festoon, dental formula 5/5 (Fig. 23) *aborensis* Warburton

Females

(The female of *capricornis* is unknown)

Palpal segment 2 with minute posteroexternal projection, ventral spur of segment 3 with blunt apex, not reaching basal margin of segment, infrainternal setae 2 (Fig. 22)

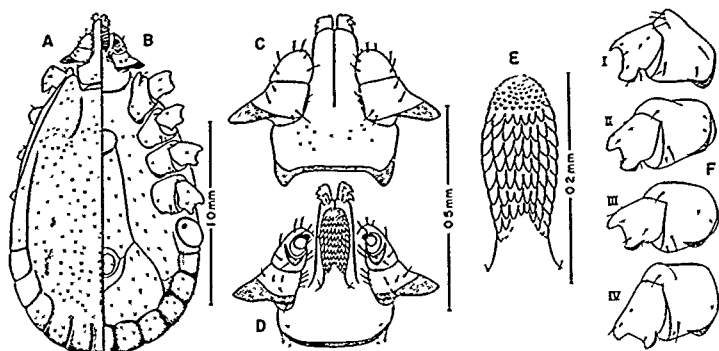
atherurus Hoogstraal, Trapido & Kohls

Palpal segment 2 without posteroexternal projection, ventral spur of segment 3 with pointed apex, reaching basal margin of segment; infrainternal setae 3 (Fig. 23).....

..... *aborensis* Warburton²

Material Examined. *H. (A.) aborensis*: THAILAND 1 ♂ (AFRIMS) BURMA 2 ♂♂ (SI), 2 ♀♀ (BM). INDIA 7 ♂♂ (SI), 1 ♀ (BM) *H. (A.) atherurus*: THAILAND 1 ♂ (AFRIMS), 1 ♂ (SI), 1 ♀ (AFRIMS), 1 ♀ (SI) MALAYSIA 3 ♂♂ (SI), 6 ♀♀ (SI) *H. (A.) capricornis*: THAILAND 3 ♂♂ (BM)

MALE (Thailand)



FEMALE (India)

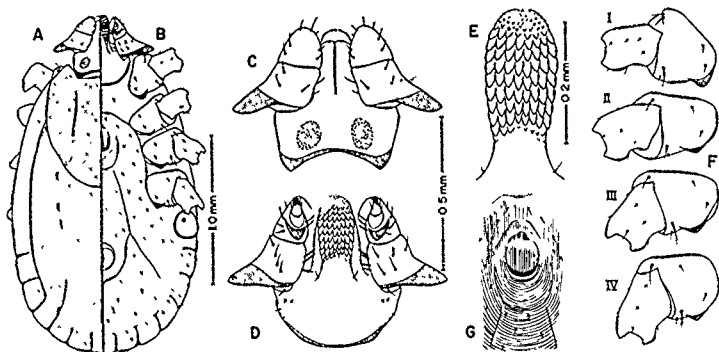
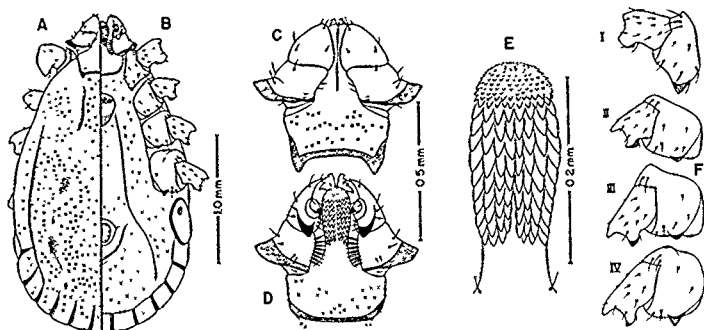
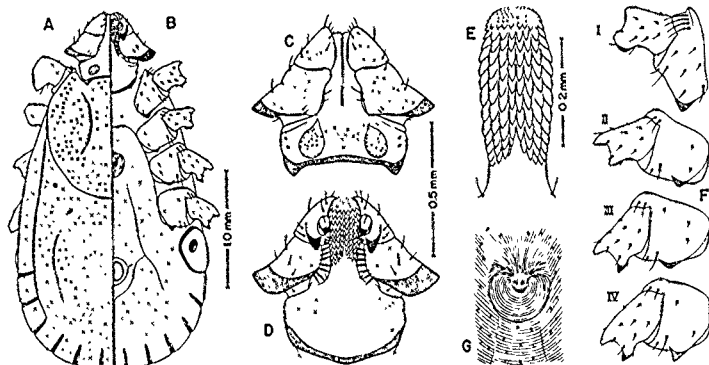


Fig. 18. *Haemaphysalis (O.) megalotmae* Rajagopalan, 1963 (female specimen from Thailand not found, drawings were prepared from Indian specimen.)

MALE (Thailand)



FEMALE (Thailand)

Fig. 19. *Haemaphysalis (O.) doerntzi* Warburton & Nuttall, 1909.

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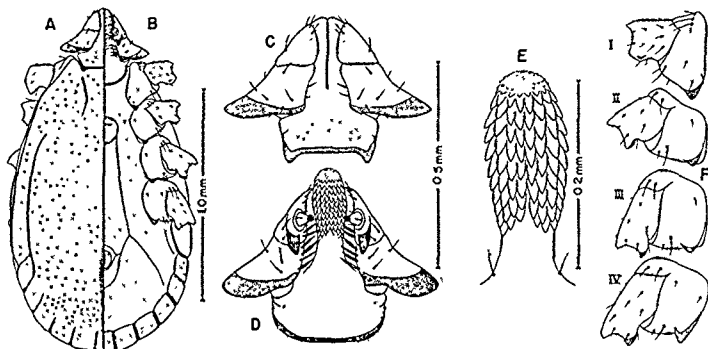
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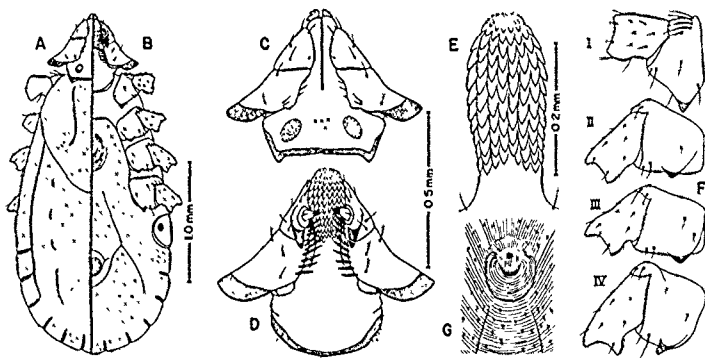
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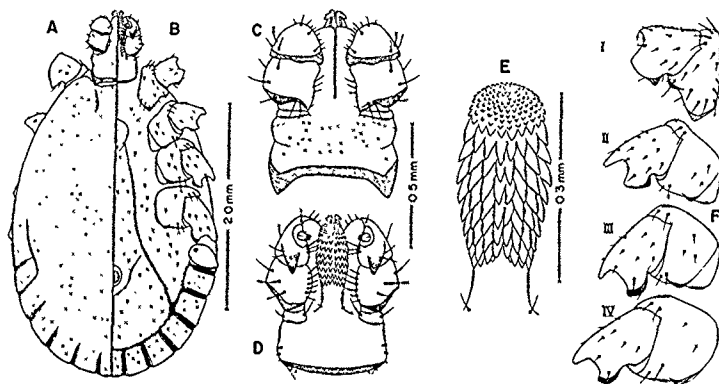
MALE (Thailand)



FEMALE (Thailand)

Fig. 20. *Haemaphysalis (O.) bancicota* Hoogstraal & Kohls, 1965

MALE (paratype, Thailand)

Fig. 21. *Haemaphysalis* (A.) *capricornis* Hoogstraal, 1966

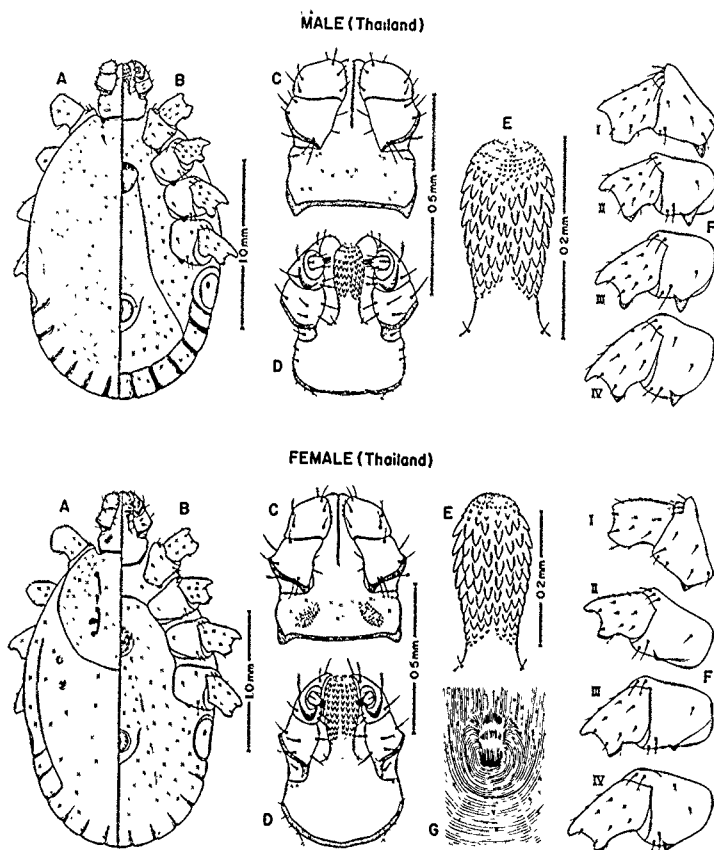


Fig. 22. *Haemaphysalis (A.) atherurus* Hoogstraal, Trapido & Kohls, 1965.

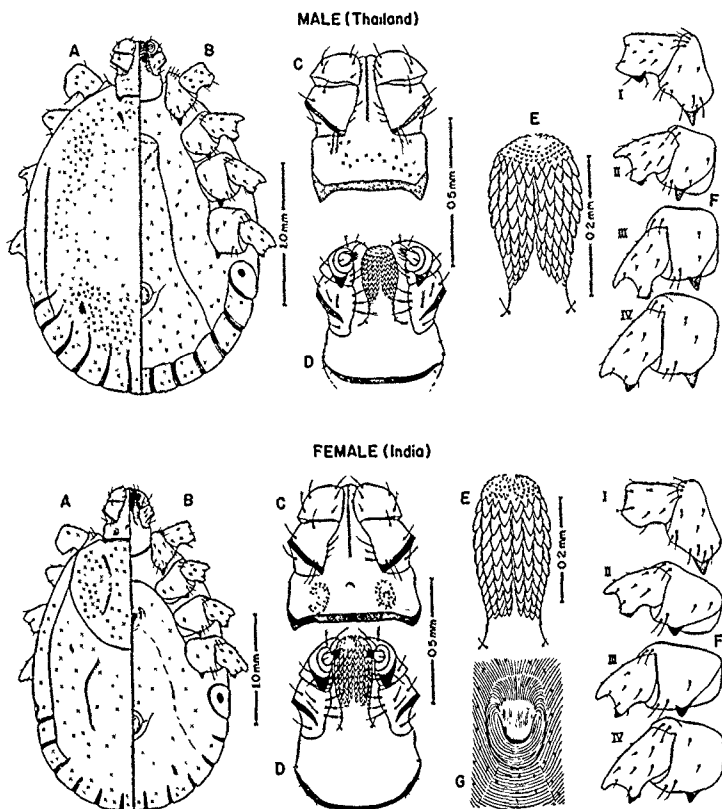


Fig. 23. *Haemaphysalis* (*A.*) *aborensis* Warburton, 1913 (female specimen from Thailand not found, drawings were prepared from Indian specimen).

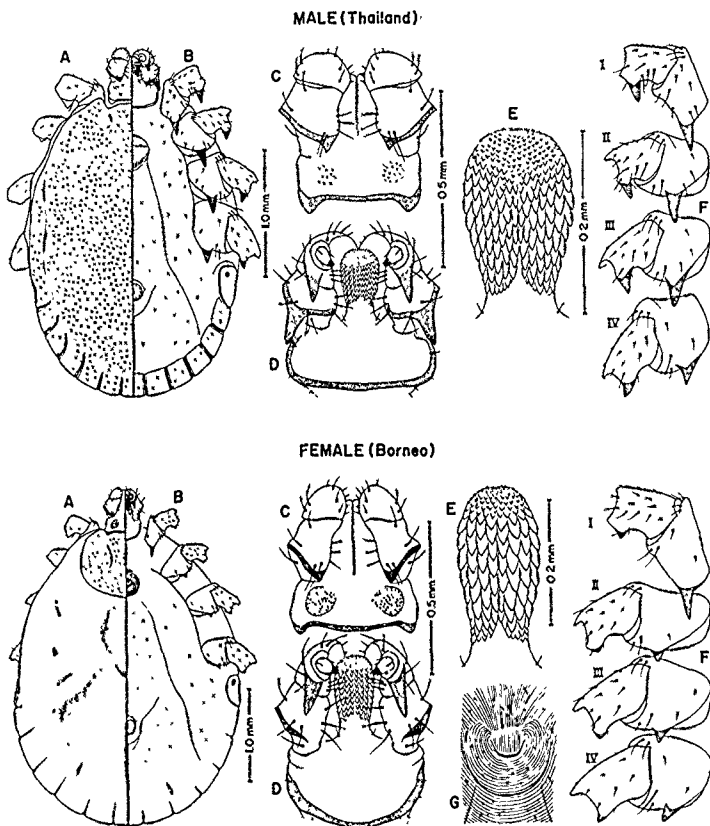


Fig. 21. *Haemaphysalis (G.) calvus* Nuttall & Warburton, 1915 (female specimen from Thailand not found, drawings were modified from published drawings of Hoogstraal & Wassef 1981)

Discussion. *Haemaphysalis capricornis* is known only from males captured on the serow (*Capricornis sumatraensis*), an Asian goat antelope, and is tentatively included in the subgenus *Aborphysalis*, material available for study is insufficient to make subgeneric placement certain (Hoogstraal et al. 1971b). This is the largest species in the subgenus and is characterized mainly by the spurlike angle of palpal segment 2 and the replacement of each coxal spur by a broad ridge.

Subgenus *Garnhamphysalis*

Material Examined. THAILAND 1 ♂ (BM)

Discussion. Only one species of the subgenus *Garnhamphysalis*, *H. (G.) calvus* Nuttall & Warburton, 1915 (Fig. 24), occurs in Thailand. Female specimen was not found.

Subgenus *Haemaphysalis*

Material Examined. THAILAND 1 ♂ (SI) INDIA: 1 ♀ (BM)

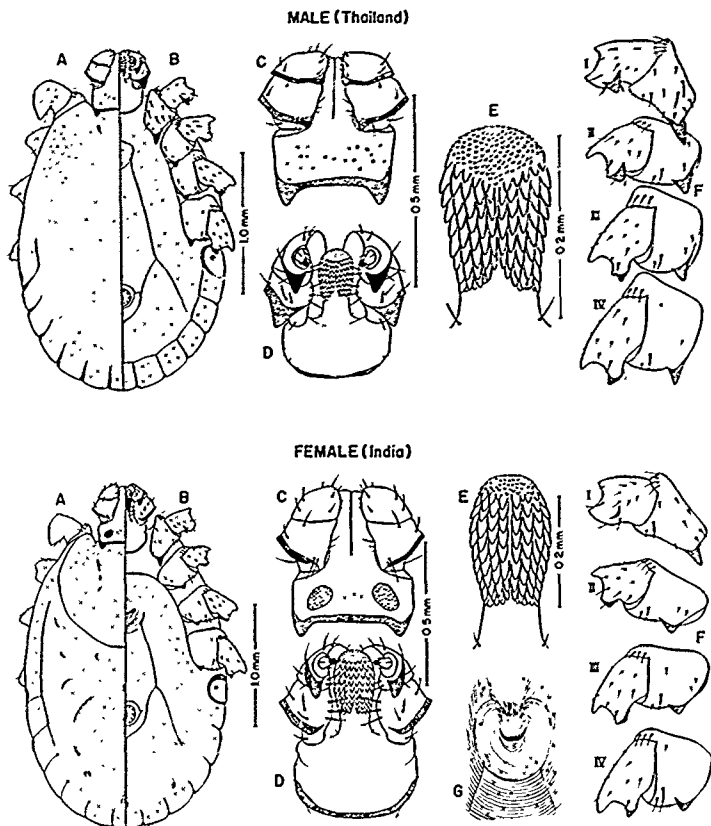


Fig. 25. *Haemaphysalis (H.) darjeeling* Hoogstraal & Dhanda, 1970 (female specimen from Thailand not found, drawings were prepared from Indian specimen).

Discussion. Only one species of the subgenus *Haemaphysalis*, *H. (H.) darjeeling* Hoogstraal & Danda, 1970 (Fig 25), occurs in Thailand. Female specimen was not found

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APPENDIX I

Host-Parasite List of Adult *Haemaphysalis* in Thailand

| | |
|----------------------------|---|
| <i>H. treguli</i> | Mammal: <i>Tragulus javanicus</i> * |
| <i>H. (A) aborensis</i> | Mammal: <i>Hystrix hodgsoni</i> (crestless Malayan porcupine). |
| <i>H. (A) atherurus</i> | Mammal: <i>Atherurus macrourus</i> ** (bush-tailed porcupine), <i>Canis familiaris</i> (domestic dog), <i>Tupaia glis</i> (common tree shrew). |
| Other: | Vegetation. |
| <i>H. (A) capricornis</i> | Mammal: <i>Capricornis sumatraensis</i> (serow). |
| <i>H. (G) calvus</i> | Mammal: <i>Selenarctos thibetanus</i> (Asiatic black bear). |
| <i>H. (H) darjeeling</i> | Mammal: <i>Arctonyx collaris</i> (hog badger), <i>Homo sapiens</i> . |
| <i>H. (K) anomala</i> | Mammal: <i>Bos</i> sp. (domestic cattle), <i>Homo sapiens</i> * |
| <i>H. (K) laspinosa</i> | Mammal: <i>Arctictis binturong</i> (banturong), <i>Homo sapiens</i> , <i>Muntiacus muntjak</i> (common barking deer). |
| Other: | Vegetation. |
| <i>H. (K) hystrix</i> | Mammal: <i>Arctonyx collaris</i> , <i>Bandicota indica</i> (Great bandicoot rat), <i>Homo sapiens</i> , <i>Rattus kukit</i> (chestnut rat), <i>Rattus rattus</i> (roof rat). |
| <i>H. (K) lagrangei</i> | Mammal: <i>Arctogalidia trichogata</i> ** (three-striped Palm civet), <i>Bos</i> sp., <i>Canis familiaris</i> , <i>Cervus unicolor</i> ** (sambar deer), <i>Homo sapiens</i> , <i>Paradoxurus hermaphroditus</i> * (common palm civet), <i>Selenarctos thibetanus</i> . |
| Other: | Flagging,** vegetation**. |
| <i>H. (K) nachchatriam</i> | Mammal: <i>Bos</i> sp., <i>Homo sapiens</i> , <i>Rattus rattus</i> , <i>Sus scrofa</i> (common wild pig), <i>Tapirus indicus</i> (Malayan tapir), <i>Tragulus javanicus</i> * (lesser mouse deer). |
| Other: | Vegetation. |
| <i>H. (K) obesa</i> | Mammal: <i>Cervus unicolor</i> , <i>Homo sapiens</i> *, <i>Melogeale personata</i> * (Burmese ferret badger), <i>Selenarctos thibetanus</i> , <i>Sus scrofa</i> , <i>Tapirus indicus</i> . |
| Other: | Flagging,** vegetation**. |
| <i>H. (K) papuana</i> | Mammal: <i>Canis familiaris</i> , <i>Homo sapiens</i> , <i>Panthera tigris</i> (Tiger), <i>Rattus boucardi</i> * (Bower's rat), <i>R. kukit</i> *, <i>R. rattus</i> *, <i>R. turtleyi</i> (yellow rajah rat), <i>Selenarctos thibetanus</i> , <i>Sus scrofa</i> . |
| Other: | Vegetation. |
| <i>H. (K) semeris</i> | Mammal: <i>Tapirus indicus</i> . |
| <i>H. (K) shimoga</i> | Mammal: <i>Bos</i> sp., <i>Bos gaurus</i> (Gaur), <i>Cervus unicolor</i> , <i>Homo sapiens</i> , <i>Bandicota indica</i> *, <i>Rattus kukit</i> *, <i>R. rattus</i> , <i>R. sabanus</i> (noisy rat). |
| Other: | Vegetation**. |

APPENDIX I Continued

| | |
|----------------------------|---|
| <i>H. (K) wellingtoni</i> | Mammal: <i>Bubalus bubalis</i> (wild water buffalo), <i>Canis familiaris</i> , <i>Melogeale personata</i> *, Burd: <i>Arctophila</i> sp. (partridge), <i>Centropus sinensis</i> ** (greater coucal), <i>Callus gallus</i> ** (red jungle fowl), <i>Gallus leucolophus</i> ** (white-crested laughing thrush), <i>Claustridium cuculoides</i> (barred fowl), <i>Meleagris gallopavo</i> * (turkey), <i>Pitta moluccensis</i> ** (blue-winged pitta), <i>Pygmonotus blanfordi</i> (Blanford's olive bulbul). |
| <i>H. (O) bandicota</i> | Mammal: <i>Bandicota indica</i> *, <i>B. sacditi</i> (lesser bandicoot rat), <i>Bos</i> sp., <i>Herpestes javanicus</i> ** (Javan mongoose), <i>Rattus</i> sp. (rat), <i>Tupaia glis</i> **. |
| <i>H. (O) doerflingeri</i> | Mammal: <i>Bandicota indica</i> *, <i>Homo sapiens</i> *, <i>Lepus penguensis</i> (Siamese hare), <i>Rattus rattus</i> , Burd: <i>Centropus bengalensis</i> (lesser coucal), <i>C. sinensis</i> , <i>Gallus erythrocephalus</i> (red headed laughing thrush), <i>Lophura nycthemera</i> (silver pheasant), <i>Mitrofa assamica</i> * (collared bush lark), <i>Phylloscopus</i> sp.* (warbler), <i>Riparia riparia</i> (gorgeted sand martin), <i>Sturnus javanicus</i> (crested myna), <i>S. nigricollis</i> ** (black collared starling), <i>S. tritris</i> (common myna), <i>Upupa epops</i> (hoopoe), <i>Zosterornis dauma</i> * (litter (small-billed) thrush), <i>Z. marginata</i> * (lesser long-billed thrush). |
| <i>H. (O) megalaimae</i> | Bird: <i>Megalaima zeylanica</i> (lineated barbet). |
| <i>H. (O) ornithophila</i> | Bird: <i>Pitta oatesi</i> (fulvous pitta). |
| <i>H. (R) asiatica</i> | Mammal: <i>Felis bengalensis</i> (leopard cat), <i>Felis</i> sp. (cat), <i>Viverra zibetha</i> (large Indian civet), <i>Tupaia glis</i> *, <i>Menetes berdmorei</i> * (Indochinese ground squirrel), <i>Rattus</i> sp.*. |
| Other: | Flagging**. |
| <i>H. (R) canestrinii</i> | Mammal: <i>Arctonyx collaris</i> , <i>Felis chaus</i> (jungle cat), <i>Herpestes javanicus</i> , <i>Melogeale personata</i> , <i>Paradoxurus hermaphroditus</i> . |
| <i>H. (R) heinrichi</i> | Mammal: <i>Bos</i> sp., <i>Canis familiaris</i> , <i>Melogeale personata</i> **. |
| <i>H. (R) koningsbergi</i> | Mammal: <i>Arctictis binturong</i> , <i>Melogeale personata</i> *, <i>Rattus rattus</i> **. |

* Immature stage only was found, ** immature and adult stages were found.

* It is noteworthy that all hosts of *H. treguli* in Thailand collected from five collections were *Tragulus javanicus* Hoogstraal et al (1972) reported *H. treguli* from Indonesia, Borneo, and Burma, all of the individuals infested *Tragulus* sp. only.